George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

TD15-PLN-003
Baseline
December 13, 1999

LAUNCH TECHNOLOGY PROJECT PLAN SPACELINER 100 INVESTMENT AREA

Advanced Space Transportation Program
TD15

CHECK THE MASTER LIST-VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE

LAUNCH TECHNOLOGY PROJECT PLAN

TABLE OF CONTENTS

LAUNCH TECHNOLOGY PROJECT PLAN

SIGNATURE PAGE

Prepared by:

Sherry Buschmann — Date
Launch Technology Project Manager

Approved by:

Garry Lyles — Date
Advanced Space Transportation Program Manager

LIST OF ACRONYMS

ARC	Ames Research Center
ASTP	Advanced Space Transportation Program
DOD	Department of Defense
CWC	Collaborative Work Commitment
FY	Fiscal Year
GPMC	Governing Program Management Council
GRC	Glenn Research Center
GSE	Ground Support Equipment
ISO	Industrial Safety Office
KSC	Kennedy Space Center
LaRC	Langley Research Center
MM.	MSFC Manual
MMI	MSFC Management Instruction
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NHB	NASA Handbook
NPD.	NASA Program Directive
NPG	NASA Procedures and Guidelines
NRA	NASA Research Announcement
PAPAC	Provide Aerospace Products and Capabilities
PDT	Product Development Team
PCA	Program Commitment Agreement
PMC	Project Management Council
RLV	Reusable Launch Vehicle
S & MA	Safety and Mission Assurance
STD	Space Transportation Directorate
TBD	To Be Determined
WBS	Work Breakdown Structure

FOREWORD

This Project Plan describes the planning and objectives for the implementation of a NASA project known as the Launch Technology Project. This plan has been prepared in accordance with the *NASA Program and Project Management Processes and Requirements,* NPG 7120.5A, and is consistent with the *NASA Strategic Management Handbook* and *NASA Program/Project Management*, NPD 7120.4. In addition, it follows the MSFC Lead Center Implementation Plan for Space Transportation System Development and Technology Programs.

I. INTRODUCTION

The available opportunities for scientific research and new space industries are limitless. It includes manufacturing medicines that are far superior to drugs made on earth, mining resources from orbiting bodies, servicing satellites in orbit, generating power, exploring new worlds and safely, routinely and affordably accommodating passengers. The current high cost of space transportation, however, has locked the door to these opportunities.

The potential growth of the commercial space market has been demonstrated in recent years. Seventy-five commercial payloads were launched in 1997. These commercial launches represented one-half of the total number of launches and a threefold increase over the previous year. This growth will not continue, however, unless the cost of space launch is dramatically reduced. Currently, other countries hold the competitive advantage for providing the launch services to support this expanding commercial space market. The US commercial space launch industry has dwindled from complete market dominance in the mid-1970s to only 30 percent of a greatly expanded worldwide market today.

The Civil Space Transportation Study, an assessment of future commercial space markets, concluded that a 100-fold reduction in launch cost ($100 per pound of payload) would result in 20 times more commercial launches than are possible today.

To enable NASA to conduct better, faster, and cheaper programs in exploration, research, and science, and to enable the US commercial sector to flourish in space endeavors such as expanded space communications and remote sensing, significant reductions in space launch costs must be achieved. NASA's role is to develop the technologies that will enable the US launch industry to recapture the commercial launch market and drive down the cost of access to space. This lower cost launch capability will enable routine DOD space operations. NASA's space transportation technology programs are focused on developing the breakthrough technologies that will enable the next generation launch systems. In particular, the Launch Technologies project will develop avionics, power, crew and payload systems, and systems integration and design tools that will enable the NASA goals and missions.

II. OBJECTIVES

The Launch Technology project has been initiated to support required technologies for meeting Spaceliner crew safety, vehicle reliability and cost goals. It was formulated with the mission of technology development and demonstration that will enable the development of launch systems and associated tools that will; 1) increase crew safety and vehicle reliability by factors of 1,000 to 10, 000

and, 2) meet the price and performance goals that are a factor of 10, even 100, less than that currently available.

The project will focus on six areas of development:

1. Avionics, Flight and Control
2. Power
3. Design and Analysis Tools
4. Systems Integration
5. Payload Systems
6. Crew Systems

Within each of these task areas, there will be multiple sub-tasks identified

.III. CUSTOMER DEFINITION AND ADVOCACY

The primary customer for the Launch Technology Project is NASA's Advanced Space Transportation Program (ASTP). ASTP is interested in the development and test of technologies that will potentially provide low-cost space transfer, have low development costs, and that will show near-term results. The Launch Technology customer base will be all inclusive of those taking advantage of the technologies developed by the Spaceliner program. They include:

- Universities/Academia
- Office of Earth Science (OES)
- Office of Space Science (OSS)
- Human Exploration and Development of Space (HEDS)
- Office of Life & Microgravity Sciences & Applications (OLMSA)
- Office of Aeronautics & Space Transportation Technology (OASTT)
- Department of Defense (DoD)
- Industry

IV. PROJECT AUTHORITY

The *NASA Strategic Plan* and the *NASA Strategic Management Handbook* assign to MSFC the Lead Center responsibility for Space Transportation Systems development. This assignment includes Lead Center responsibility for the Advanced Space Transportation Program of which the Launch Technology Project is a part. The Launch Technology Project Office is responsible for project implementation and management. The Launch Technology Project Office has direct commitments with MSFC and other NASA centers through the prime contractors or between the Project Office and NASA Centers. The MSFC GPMC is responsible for oversight of the Launch Technology Project.

V. MANAGEMENT

A. Organization and Responsibilities

1. NASA Headquarters

The Office of Aero-Space Technology (Code R) is the NASA Headquarters office responsible for the Launch Technology Project.

2. Field Centers

The field centers involved in the Launch Technology Project include: George C. Marshall Space Flight Center, Langley Research Center, Ames Research Center, Glen Research Center, and Kennedy Space Center. The involvement of each center is described below:

a. George C. Marshall Space Flight Center (MSFC)

The MSFC, as the lead center for Space Transportation Systems Development and the Center of Excellence for Space Propulsion, is the principal NASA Center for research, technology maturation, design, development, and integration of space transportation and propulsion systems, including both reusable and expendable launch vehicles, and vehicles for orbital transfer and deep space missions.

The Advanced Space Transportation Program, X-33, and Future-X/Pathfinder Program Offices have been consolidated with other space transportation development and technology activities at the MSFC into a new organizational unit, the Space Transportation Directorate. This consolidation enables integrated coordination of ongoing advanced space transportation activities together with strategic planning for new initiatives, and will provide a single focal point for the lead center responsibilities within the mission area of space transportation. The Space Transportation Directorate is responsible for executing the NASA Lead Center role assigned to MSFC for space transportation systems development activities. Integrates program and project level planning, research, and development to ensure a well-balanced space transportation development program that meets the Agency's aggregate needs in a coordinated and integrated manner.

Manager, Advanced Space Transportation Program, manages and integrates activities for conducting research and technology maturation and demonstrations applicable to advanced space transportation systems. The ASTP Program Manager serves as principal advisor to the MSFC Assistant Director for Space Propulsion Systems concerning planning, implementation, and evaluation of MSFC's assignment as

Propulsion Center of Excellence. The established programs, ASTP, X-33, and Future-X/Pathfinder functionally report to the MSFC Center Director. All program office personnel are being assigned administratively to the Space Transportation Director. The individual program offices are kept small and share administrative staff, program control as well as collocated engineering and procurement support.

Responsibility for the Launch Technology Project falls under the ASTP. MSFC will manage all of the tasks of this project. In addition, MSFC will contribute excellence in the area of Avionics and Flight Control, and Systems Integration types of development.

The Launch Technology Project Manager has a small team consisting of members of involved Directorates within MSFC, and representatives from other involved centers. This team is responsible for planning, coordinating and interfacing with other projects and organizations as appropriate to accomplish the job.

Program Management (Level II)

Overall Program Management is provided by the Advanced Space Transportation Program Office.

Project Management (Level III)

The Project Manager is assigned by MSFC's ASTP office and reports to the ASTP Program Manager (Level II). The Project Manager is responsible for developing an approach to meet the objectives established by the ASTP Program Manager; developing lower level project constraints such as budget, resources and schedule; and implementation planning that coordinates NASA and contractor assets. The Project Manager will be aided and assisted in all of these activities by a Deputy Project Manager also assigned by the ASTP office.

The products of the Project Manager are:

- Project Plan. The Project Plan shall be written in accordance with NPG 7120.5A
- Integrated Project Schedule. The Integrated Project Schedule shall be developed using Microsoft Project and will contain all tasks identified by the appropriate teams and the Project Management. The tasks shall be logically linked with the critical path identified. The project schedule shall contain detailed schedules of all project elements and shall be updated in a timely manner. The project schedule shall contain the baseline schedule and deviations from the baseline. The Project Manager must approve changes to the baseline schedule.

- Resource Allocations (POP inputs). The Resource Allocations contain estimates of budget requirements and manpower requirements. This report indicates when budgeted funds will be obligated and costed as well as the cost of in-house manpower and it's phasing. The Project Manager is assisted by a business manager who is assigned by the ASTP management. The business manager's primary responsibility is to assure that all procurements are planned and purchased in time to support the project schedule. The Business Manager shall work with the PDTs to evaluate procurement needs and schedule; track expenditures; and reports progress and issues to the project manager.
- Collaborative Work Commitments (CWC). The Project Manager will develop CWC's per MSFC-P03.1-C01. The Project Manager will be assisted by the Deputy Project Manager and Lead Systems Engineer. CWC's are controlled by the Project Manager and held as a quality record in accordance with MSFC-P16.1 for 6 months after completion of the task.

Engineering Management (Level IV)

The CWC manager is responsible to the project for ensuring that all engineering aspects of funded tasks, including in-house, other centers and contractor responsibilities are accomplished within the technical requirements and cost and schedule restraints.

CWC management functions include:

- Establish overall organizational responsibilities and points of contact.
- Provide project manager development effort task summaries including; objective, approach, benefit, metrics, schedule/major milestones, participants and budget.
- Provide project manager monthly status reports.
- Provide the Project manager with information needed to assist the technical and fiscal planning and decision processes and support program reviews.
- Provide liaison between technology development and potential benefiting organizations.
- Insure status and technical data is disseminated to benefiting programs and organizations.
- Develop and maintain task agreements with MSFC participating organizations.
- Provide liaison between the development lead and the MSFC participating as required.

- Work with benefiting organizations to identifying and prioritizing specific technology needs.

MSFC Task Managers will be assigned for each task funded within the project. Their role will be technical with regard to the nature of the work being conducted in the task.

b. Langley Research Center (LaRC)

Langley will provide technology development in the area of both Sensors, Avionics and Flight Control.

c. Ames Research Center (ARC)

Ames is responsible for the design and demonstration of sensor development and integrated vehicle health management architectures as funded within the project.

d. Glenn Research Center (GRC)

Glen will contribute ideas and expertise for the advancements of power systems and sensor development.

e. Kennedy Space Center (KSC)

Kennedy will develop critical spaceport technologies including an automated flight range architecture and ground health management systems. In addition, experience with Ground Support Equipment (GSE) will aid in the development of new ideas in the area.

B. Special Boards and Committees

The Project Manager shall schedule independent reviews with technical experts not associated with the development activity. These reviews will coincide with the design reviews.

C. Management Support Systems

The following management systems will be utilized with the Launch Technology Project. In addition, other systems within the agency are being reviewed and considered as potentials.

1. Marshall Resources Tracking System (MARTS)

The MARTS system for tracking funding authority, commitments, obligations, cost and disbursements will be utilized by Launch Technology Project.

2. Workforce Information System (WIS)

The WIS system will be utilized for tracking the civil service workforce associated with Launch Technology Project.

3. Automated Procurement Request System (APRS)

The S&E APRS system will be used for the Procurement Requests (Form 424) process.

4. Virtual Research Center (VRC)

The VRC is an Internet-based project management and document management system that allows all project team members access to project documents, drawings, meeting notes, assigned action items and the group calendar.

5. Other Management Systems

Current plans call for the implementation by June 1, 2000 of the Integrated Financial Management Planning (IFMP) system. This is a mandatory, agency wide tool for budgeting, tracking and analyzing funding.

VI. TECHNICAL SUMMARY

The Launch Technology Project will develop and demonstrate the technologies required to achieve safer, more reliable and affordable space transportation systems. Each of tasks within this project will have project requirements, systems, system operating concepts, ground support systems, facilities, logistics and mission results analysis outlined in individual task project plans. The core technology discipline areas, and funded task within each area are listed below.

A. Avionics and Flight Control

Design, develop and test advanced avionics components and subsystem to enable the development of a reliable, low-cost and lightweight avionics system. Technologies such as lightweight distributed modular avionics, scaleable intelligent networks, Fly-By-Wire/ Light and intelligent control system components will be integrated to produce a highly modular and flexible avionics system. Modular and localized intelligent sensor based architectures will increase the system level reliability and improve overall flight safety.

The following projects are currently funded for FY00:

1) (AV-002) Distributed Reconfigurable Avionics (DRA) (WBS 1.8.4.1.2)

The DRA task will develop a small, light-weight, low-cost, modular, dynamically re-configurable avionics network that can be configured to perform various processing, data management, and

signal conditioning functions, in conjunction with multiple like units arranged throughout the launch vehicle.

There are four key elements to the DRA task:

1. Determine architecture and reconfiguration strategies; identify requirements for processing complexity; identify requirements for input/output and signal-conditioning for vehicle sensors; and develop strategies for serial communication

2. Evaluate the Chips-on-Board (COB)/Flexible Interconnect (FI) fabrication method as an approach to eliminate intermediate packaging of electronic devices and utilize the structural, thermal, and electrical properties of composite materials to provide an integrated electrical/structural chassis.

3. Develop the detailed design of core computer, implementing both fixed core logic and in-circuit programmable design to support flexible reuse.

4. Identify existing component technology, and push development in areas of performance as required to meet task objectives. Design and procure any custom components (multi-chip modules, application specific integrated circuits, high-performance transmitters/receivers, etc.) to perform processing and conditioning functions.

2) Robust Guidance, Navigation and Control (WBS 1.8.4.1.3)

This task will develop a guidance and control component system that leverages from current MOTS/COTS programs. It will utilize components developed for DOD or commercial ventures to obtain a reliable guidance and control system without incurring all of the development costs. This will require the evaluation of INS/GPS systems, IMUs and GPS receivers.

3) (AV-10) SFINX (Scalable, Fault-tolerant Intelligent Network of Xducers) (WBS 1.8.4.1.4)

This task will utilize advances in communication methods as applied to instrumentation and control. This communication method will enable redundant, expandable, plug-and-play networks of smart sensors and smart actuators with substantially fewer wires and connectors in the system. It will implement automated built-in test, checkout, health management, redundancy management, component data sheets, etc. Many of the smart functions in this task will be hardware implementable to reduce software demands. The advanced features will be demonstrated in a ground simulation and in the last year, hardware will be produced for a potential flight demonstration.

4) (AV-4,5) Advanced Sensor and MEMS (WBS 1.8.4.1.5)

This task will utilize advances in sensor technology especially microfabricated sensor technology and MEMS (MicroElectricalMechanical Systems) to develop and test the next generation of sensor

technology. This will allow the development of sensor arrays, miniaturization of sensor systems, integration of smart electronics, and the inclusion of wireless telemetry.

Semiconductor processing to deposit multiple sensors and sensor conditioning on the same chip or in a small region will be developed. A in-situ engine monitoring task will further develop microfabricated thin film sensors and to integrate various thin film sensors needed for the propulsion system into a single package.

5) (AV-13,15) High Density Structural Sensors (WBS 1.8.4.1.6)

This task will develop multiplexing (MUX) technology for F/O and AE structural health monitoring sensors. The goal is to monitor 10,000 low cost F/O sensors (weighing < 1 pound). high density sensors. This will enable practical large area structural health monitoring. As part of an overall IVHM system, high density sensors will contribute to the reduced operating costs, increased structural reliability, and improved safety that is critical for future RLV's.

6) Smart Sheet (WBS 1.8.4.1.7)

This task will assess technology for potential applications on the structural health management for space vehicles. Task will be in accordance to "Active Sensing of Cryogenic Composite Structures for Space Transportation Applications", by Fu-Kou Chang, dated 6-21-99.

Power

Design, develop and test power systems, power control and distribution components and subsystems for insertion into a highly reliable and low-cost system for a reusable launch vehicle. Power generation, storage and distribution systems contained would enable development of a fully electric actuation and control architecture. Elimination of hydraulics would increase flight safety and system level reliability. Technologies contained within the planned program include power generation and processing & control subsystems/modules, electromechanical actuators, polymer batteries, advanced fuel cells, and supporting passive and active component level technologies.

The following projects are currently funded for FY00:

1) PW-001/ Super Capacitors

This task will produce packaged super capacitor system. Super capacitors utilizing the carbon nickel electrode structure patented at Auburn University Space Power Institute (AU-SPI) will be developed for 120 V and 270 V system applications. Two other electrode chemistries/configurations from the prototype to the manufacturable product stage will be independently developed. These two electrodes are Ruthenium Oxide (RuO_2) from on-going work at AU-SPI and Vanadium Nitride from on-going work at T/J Technologies.

2) PW-002/ High-Energy Density Electrochemical Capacitors (ECs)

This task will develop and test ECs, with high energy density as a primary energy source. Using ECs instead would eliminate the need for spare batteries, battery specialists, activation processes and the tracking of expiration dates, thereby reducing operation costs, turnaround time, and ground facilities. Using an EC with a battery will reduce source weight.

3) PW-005/Lithium-Based Rechargable Batteries

This task will develop a high energy density, rechargeable lithium-based battery for high pulse,high energy density applications.

4) PW-006/Modular High Voltage Switchgear

This task will develop advanced, modular, high-voltage, high-current switchgear for Bantam/RLV applications. Today's switchgear is inadequate for the power levels contemplated for electric powered flight control actuator systems.

Integrated Design and Analysis Tools

Develop and demonstrate integration, analysis and design tool technologies. Serve as tools focal point for coordination of tool development of other projects. Included in this effort is the generation of software packages that demonstrate significantly more rapid design and analysis turnaround times. The resulting shorter analysis/design cycle times will significantly contribute to evaluating candidate vehicle concepts quickly, identifying enabling technologies, and implementing future launch systems more rapidly. In addition, significant effort will be applied to developing an integrated design environment which will interconnect analysis and design tools and provide a more efficient interface between the various tools to further streamline the design cycle.

This is a FY00 new start. Task requirements and plans are being developed.

Crew Systems

Develop and test a safe and operationally viable aerospace vehicle Crew Visibility System concepts. Develop associated technologies, data, and guidelines to enable space crew operations in all levels of visibility and weather. Assess crew role during ascent (including aborts) and descent (nominal & off-nominal) and develop concepts and aids to support the crew during these mission phases. This work includes prototyping, testing, and evaluating crew/vehicle automation concepts within ascent and descent scenarios and applying airline operations methods for enhanced space crew operations. Integration of advanced crew aids will enhance both crew productivity and safety.

This core area is currently not funded.

VII. SCHEDULES

Each funded task has and maintains a task schedule. The following are significant milestones from those schedules. An * indicates a milestone in the program plan.

**** Milestone (2QFY00)***: Complete evaluation of high power density Electrochemical Capacitor (EC) technologies.

Output: Selection of two out of 14 Electrochemical Capacitor (EC) technologies to pursue in the development of a, 30 kW/kg power density/ 3Whr/kg energy density, power system.

Outcome: Significant reduction in the weight, up to 40 %, of future launch vehicle power storage systems possible when high power density Electrochemical Capacitors technology are used in conjunction with batteries or fuel cells.

**** Milestone (3QFY00)***: Manufacture and test a prototype 30 V, 10 F Nickel Carbon electrode Chemical Double Layer Super Capacitor.

Output: Electrical, and environmental test data demonstrating Super Capacitors can operate in Solid Rocket Booster environments. Electrical data is a projection of needs for proposed Electric APU and Electromechanical Actuation applications.

Outcome: A hybrid power source utilizing super capacitors and traditional batteries will provide significant weight savings over battery alone configurations of at least 50%.

**** Milestone (4QFY00)***: Complete the Guidance Navigation and Control Systems Evaluation Lab.

Output: Demonstrate the capability to test and validate GPS/IMU systems and conduct real time navigation solution tests.

Outcome: Capabilities will enable the development and test of advanced antonymous vehicle guidance, navigation and control systems.

**** Milestone (4QFY00)***: Laboratory test of a Scaleable Fault-tolerant Intelligent Network of Transducers hardware concept.

Output: Demonstrate four intelligent I/O components (sensors and actuators) including electronics to interface the components to a transducer bus. The bus (coax) will provide both power and communications to the I/O components using modified IEEE 1451 smart sensor standards.

Outcome: Significantly reduce avionics weight, simplify fault-tolerant architecture design to any level of redundancy up to quad systems, eliminate wiring and associated connectors, provides enhanced built-in-test and health management functions, automate checkout, diagnostics, and repair processes, minimize system size, weight, power, and cost

VIII. RESOURCES

Funding for the Launch Technology program covers all effort, materials and services. The program funding plan by fiscal year are shown below:

A. Funding Requirements (NOA in Millions)

FY00	FY01	FY02	FY03	FY04	TOTALS
$ 7.2	$28.6	$35.6	$31.8	$29.9	$133.1

B. Institutional Requirements (FTE)

FY00	FY01	FY02	FY03	Totals
34	83	100	125	342

IX. CONTROLS

The Launch Technology Project is subject to the controls as contained in NASA Procedures and Guidelines, NPG 7120.5A, effective April 3, 1998. The Launch Technology Project Plan establishes the top level technical, schedule, and cost controls placed on the program. A semi-annual review of this plan will be performed to accommodate the changing nature of advanced technology projects. All revisions to the Program Plan will be coordinated with the Deputy Associate Administrator for Space Transportation Technology. Responsibilities for Program and Project Management are as follows:

A. Headquarters Responsibilities

Associate Administrator for Aeronautics and Space Transportation Technology

a. Providing program advocacy.
b. Establishing program requirements and metrics.
c. Recommending the level of GPMC oversight for each new program.
d. Assigning program and selected project responsibilities to Lead Centers.
e. Recommending new programs to the Agency PMC.
f. Developing, coordinating, and maintaining the PCA.
g. Approving Program Plans.
h. Assessing program performance against requirements and customer expectations.
i. Ensuring timely resolution of multiple program and project issues with assigned enterprise.

j. Serving as a member of the GPMC.
k. Allocating budgets to programs.

B. Center Responsibilities

1. The Lead Center Director (MSFC)

a. Serving as Chairperson of Lead Center PMC.
b. Supporting the Associate Administrator of Aeronautics and Space Transportation Technology in program formulation.
c. Providing overall direction, control, and oversight of program implementation.
d. Appointing the program manager.
e. Concurring on the Program Plan for Associate Administrator approval.
f. Assigning work to other Centers.
g. Integrating institutional resources with program needs.
h. Coordinating cross-Center activities.
i. Ensuring compliance to policy/standards.
j. Maintaining dual path for Quality and IA.
k. Developing and maintaining program/project implementation policies and procedures compliant with NPD 7120.4, NPG 7120.5A, and ISO 9000.

2. Performing Center Director (MSFC)

a. Performing advanced concept studies in support of Agency and enterprise strategic plans.
b. Supporting the program formulation.
c. Project implementation and oversight.
d. Developing and maintaining program/project implementation policies and procedures compliant with NPD 7120.4, NPG 7120.5A, and ISO 9000.

3. ASTP Program Manager

a. Program planning, including: recommendation of program objectives, requirements, implementation guidelines, program integration, budget and milestones, and preparation of Program Plans and PCA's.
b. Developing, recommending, and advocating the program resources.
c. Execution of the Program Plan and oversight.
d. Approving Project Plans and associated changes to these documents.
e. Reviewing and reporting program/project performance.
f. Establishment of project requirements and performance metrics.
g. Allocating budget to projects.
h. Control of program changes.

i. Establishing support agreements.

4. The Launch Technology Project Manager

a. Preparation and maintenance of the Project Plan, specifications, schedules, and budgets.
b. Acquisition and utilization of participating contractors.
c. Execution of the Project Plan.
d. Reporting project status.
e. Approving Task Agreements.
f. Conducting design and all other appropriate reviews.
g. Participation in Configuration Control Board Activity.

X. IMPLEMENTATION APPROACH

A. Implementation Plan

The Launch Technology Project is a development project intent on developing a technologies that reduce risk and cost associated with space launch vehicles. Examples of methods for achieving this include the Distributed Reconfigurable Avionics task (DRA) within the Avionics and Flight Control task area. By reducing size and weight, making it modular and dynamically reconfigurable, the DRA will provide for reuse of the network for different processing, data management and signal conditioning functions. For Integrated Design Tools, the ability to incorporate several design packages in a single integrated tool will provide for the ability to iterate through design cycles faster and more cost effective.

B. Project summary WBS

1.8.4 Vehicle Systems
1.8.4.1 Avionics, Flight and Control (CWC - TD15-60)
1.8.4.2 Power (CWC - TD15-62)
1.8.4.4 Analysis and Design Tool Development (CWC - TD15-70)
1.8.4.5 Systems Integration (CWC - 290)
1.8.4.6 Payload Systems (CWC -291)
1.8.4.7 Crew Systems (CWC- 292)

XI. ACQUISITION SUMMARY

The Launch Technology Project acquisition strategy is based on both NASA in-house and contracted activities. All of the planned individual contracts are currently anticipated to be less than $10M. Because of the experimental nature of the Launch Technology Project and tight time schedules, every emphasis will be placed on short procurement approaches. Existing contracts, NASA Research

Announcements, Purchase Orders, and Support Agreements will be utilized to the greatest extent possible.

XII. PROGRAM/PROJECT DEPENDENCIES

Work done within the Launch Technology Project will interface with work done in the areas of Propulsion, Operations Technologies and Airframe Technologies being managed at MSFC, KSC and LaRC, respectively.

XIII. AGREEMENTS

A. Internal NASA Agreements

MSFC has been assigned as the Lead Center for the Launch Technology Project and is responsible for project implementation and management. The Launch Technology Project will require significant coordination between MSFC and the other participating centers. Coordination on specific technology development activities will be dictated by circumstances on an "as-needed" basis.

B. External Agreements

The Launch Technology Project is expected to have external agreements through Contractors and other agencies. All external agreements will be determined by competition as part of the overall acquisition strategy.

C. NASA/DoD Agreements

NASA has been assigned the Lead Agency for the development of Reusable Space Transportation systems, most of which have applicability for future DoD technology requirements. NASA and the Air Force have signed a Memorandum of Agreement calling for cooperative technology development and demonstration in support of NASA's Advanced Space Transportation Program and the military Space Operations Vehicle. The Air Force has submitted a letter showing support for the SpaceLiner 100 class RLV and their intent to procure launches.

XIV. PERFORMANCE ASSURANCE

Quality

A quality plan will be prepared for the Launch Technology Project that is in accordance with requirements of MSFC-P02.1-CO1 for flight task/projects.

Launch Technology flight hardware designed, developed and built in-house at MSFC will be in accordance with the MSFC-P02.1-CO2, Marshall Quality Manual (MQM). In-house hardware may be built to dated drawings with the approval of the Chief Engineer and the Lab lead, as specified in the Launch Technology Configuration Control Plan. As built drawings will be submitted to the MSFC Configuration Control Process as specified in the Launch Technology Configuration Control Plan.

Due to the limited scope of the Launch Technology flight demonstration experiments, flight hardware may be commercial off-the-shelf as long as it meets the requirements specified in the Launch Technology Systems Specification.

Launch Technology flight hardware purchased from outside vendors is not required to be ISO 9000 compliant. Launch Technology flight hardware purchased from outside vendors will be based on the specific requirements of NHB 5300.4(1C). Tailoring of these requirements will be reflected in the Launch Technology Quality Plan and/or in the vendor purchase order/contract.

Launch Technology flight hardware purchased from outside vendors must be delivered with a Certificate of Compliance (COC) and an acceptance data package as specified in the purchase order or contract.

Quality record activities will be performed in accordance with MSFC-P16.1, Control of Quality Records. The project manager will be custodian of these records in accordance with ISO-STP-05, Space Transportation Programs Quality Records Operational Work Instruction (OWI).

XV. RISK MANAGEMENT

A risk management plan will be prepared for the Launch Technology flight task/projects.

Due to the advanced technology development program, an aggressive Risk Management Plan will be required to effectively manage the Launch Technology project. This plan will document a continuous process that:

- identifies risks
- analyzes their impact and prioritizes them
- develops and carries out plans for risk mitigation, acceptance, or other action
- tracks risks and the implementation of mitigation plans
- supports informed, timely, and effective decisions to control risks and mitigation plans
- assures that risk information is communicated among all levels of the project

Risk management begins in the formulation phase with an initial risk identification and development of a Risk Management Plan and continues throughout the product's life cycle through the disposition and tracking of existing and new risks.

XVI. ENVIRONMENTAL IMPACT

The Launch Technology project will focus on three primary environmental areas: minimizing future problems through an active pollution-prevention program, conducting all operations in compliance with environmental requirements, and preserving our rich natural and cultural heritage for future generations. Plans will be developed to address these areas for flight task/projects.

XVII. SAFETY

A safety plan will be prepared for the Launch Technology flight task/projects.

The Launch Technology Project will develop safety guidelines to provide for the early identification, analysis, reduction, and/or elimination of hazards that might cause the following:

- Loss of life or injury/illness to personnel
- Damage to or loss of equipment or property (including software)
- Unexpected or collateral damage as a result of tests
- Failure of mission
- Loss of system availability
- Damage to the environment

The Launch Technology Project will develop a safety plan that details such activities as system safety, reliability engineering, electronic and mechanical parts reliability, quality assurance for both hardware and software, surveillance of the development processes, "closed loop" problem failure reporting and resolution, environmental design and test requirements. The plan shall be developed early in the project formulation process for each task, as required. Mission success criteria shall be defined to aid in early assessment of the impact of risk management trade-off decisions. The safety and mission success activity shall accomplish the following:

- Provide for formal assessment and documentation of each hazard, with risks identified, analyzed, planned, tracked, and controlled in accordance with section 4.2.2.c. and the hazard reduction protocol in reference c.
- Provide for a safety assessment and certification regarding readiness for flight or operations, explicitly noting any exceptions arising from safety issues and concerns.
- Utilize a quality management system governed by the ISO 9000 standard, appropriate surveillance, and NASA Engineering and Quality Audit (NEQA) techniques.

XVIII. TECHNOLOGY ASSESSMENT

Technology development is the thrust of this project. Ongoing assessment of needs for technology will be conducted by project management to insure that long term Spaceliner goals can be met.

XIX. COMMERCIALIZATION

Many of the technologies to be demonstrated have direct commercial application.

XX. REVIEWS

A. Management Reviews

Management Reviews will be scheduled during the life of the project. The type and frequency of the reviews will be established according to the unique needs of the Project and the Program Office. The reviews will be scheduled to keep program and project management informed of the current status of existing or potential problem areas. Agency management will be informed, in advance, of the schedule and agenda of the major reviews and will be invited to participate at their discretion. Special reviews by any level of management will be conducted when the need arises.

1. Lead Center Program Management Council (PMC) Review

The Marshall Space Flight Center lead center PMC will review the Launch Technology Project annually. The reviews will cover overall status information, including schedule, change, performance, funding, interfaces coordination, and other management and technical topics. The Lead Center PMC review will also assess project progress against metrics and criteria proposed in procurement instruments.

2. Quarterly Program Review

A quarterly program review will be held to review cost, schedule, and technical issues. The location of the review will be determined on a case-by-case basis. Participants will include, as a minimum, the program managers of the ASTP and STD offices.

3. Other Reviews

Other independent reviews will be scheduled as required and will include the participation of all NASA Centers involved in the Launch Technology Project. The reviews will

cover the overall status information and will include schedule status, change status, performance status, interface coordination, and other management and technical topics.

B. Technical Reviews

Each technology development effort will be reviewed at six-month increments to assess progress. Decisions for continuation, redirection, and/or cancellation will be made at that time.

XXI. TAILORING

The requirements of NASA Policy Directive (NPD) 7120.4A and NASA Procedures and Guidelines (NPG) 7120.5A apply to this program as tailored by the ASTP Program Plan and this Project Plan.

XXII. CHANGE LOG

EFF. DATE	STATUS	DOC. REVISION	DESCRIPTION